Partially and Fully Replacements of Cement and Sand with RHA and M Sand and its Effects on Properties of Normal Strength Concrete M20

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Abstract— Concrete is a widely used in civil engineering structural material. Fine aggregate is one of the most important materials in concrete. Natural river sand is the most commonly used for the fine aggregate but in this proposal we replace the river sand by M-sand with different percentages and cement is the binding material uses of the cement is more the cost of the construction also more so we replace the cement by partially with RHA. In this proposal we prepared with normal strength of the concrete of M20 grade concrete with partially and fully replacement of cement and sand with percentages of 15% of RHA and 25%,50%,75%,and 100% by M –sand respectively.

Keywords: Compressive Strength, Ultrasonic Pulse Velocity, Rebound Hammer Test, Water Absorption Test

I. INTRODUCTION

Concrete is the mostly used construction material due to its structural stability and strength. Materials used for making concrete come from the earth's crust. Thus, it depletes its resources every year creating ecological strains. As per the survey and research it was found to be that there should be a replacement for the concrete materials in the place of cement and the fine aggregate because of the depletion and the cost. The replacement materials should be in such a way that, they are cost worth and the materials available at the local sites which decrease in the transportation cost and also the time. The Replacement of the cement can be of about 5, 10, 15 percentages as per the research. Sand is one of the main materials used in the construction and it is used about 35% of the volume of concrete. While the Natural sand was excavated from the river beds which is found to be low cost. By the degradation of the sand from the river it effects the environment and cause damage to the earth. The Durability of the concrete the replacement is done with the Manufactured Sand also called as the robotic sand. The Manufactured sand is finely graded and it is the best replacement for filling of voids in the cement aggregate. Rice Husk Ash (RHA) is one of the best replacements for the cement which is partially replacement with 15% of the cement with it. As the material is contains of high amorphous silicon material and it has the pozzolonic effect.

II. MATERIALS

The physical properties of the materials used in the concrete based on the standard experimental code laid down in IS and BIS codes involved with the present project on investigation of sustainable Concrete Using Rice Husk Ash and Manufactured-Sand of grade M20.

A. Ordinary Portland cement (53 Grade)

Cement is a good substance which acts as a binding agent for materials like sand, coarse aggregate and water. In this experiment physical properties were tested for the cement taken from the Penna Cement of 53 grades on the basis of IS: 403-1968 code provision. The physical properties of the cement are shown below Table 1

S.NO	Particulars	Results
1	Normal Consistency	32%
2	Fineness Of Cement	5
3	Initial Setting Time	30min
4	Final Setting Time	10 Hours
5	Specific Gravity	3.15
6	Soundness Of Cement	6mm

Table 1: Physical Properties of Cement

B. Coarse Aggregate

The aggregate which are retained on 4.75 mm IS sieve is normally termed as coarse aggregate. The size of the coarse aggregate should b at least of the 5 mm less than the clear cover or 20 mm. In this experimental investigation used of the coarse aggregate are 20 mm and 12.5 mm crushed aggregates. The physical properties of the coarse aggregate are shown Table 2

S.No	Particulars	Coarse aggregate
1	Crushing value	19.689 %
2	Impact value	16.380 %
4	Shape test	
	Flakiness index	9.019 %
	Elongation index	10.116 %
5	Bulk density	
	Bulk density without compaction	1.390 Kg/lit
	Bulk density with compaction	1.517 Kg/ lit
6	Specific gravity	2.681
7	Water absorption	0.3

Table: 2 Physical Properties for Coarse Aggregate

C. Fine Aggregate

The aggregate which passes through 4.75 mm IS sieve and retained 60 µ IS sieve. They can be made available from river banks or crushing of the stones. The fine aggregate again is divided based on IS 383:1970 by zones wise. They are fine, medium and coarse depending upon fineness modulus of the fine aggregate. In this experimental investigation the fine aggregate are used two types they follows below:

1) River sand
2) M-Sand

1) River Sand

In this experimental investigation used river sand is taking from Swarnamukhi river banks near Sri Kalahasthri, Chittoor (Dist), Andhra Pradesh. The river sand may be used as a depending upon the grain size coarse medium and fine. The physical properties of the river sand are shown Table 3

S.No	Particulars	River sand
1	Specific gravity	2.61
2	Bulk density	
	Bulk density without compaction	1.618 Kg/lit
	Bulk density with compaction	1.763 kg/ lit
3	Water absorption	1.2 %
4	Bulking of sand	14%

Table 3: Physical Properties of River Sand

D. M-SAND

In this experimental investigation used M-SAND is replacing of river sand. This M-SAND is taking from crushed stone from Chandragiri quarry near Chandragiri, Chittoor (Dist), Andhra Pradesh. The physical properties of M-sand are shown in Table 4.

S.No	Particulars	River sand
1	Specific gravity	2.64
2	Bulk density	
	Bulk density without compaction	1.709 Kg/lit
	Bulk density with compaction	1.992 Kg/ lit
3	Water absorption	1.6%
4	Bulking of M-SAND	12%

Table 4: Physical Properties of M-sand

S.No	% Of RHA & M Sand	Cement (Kg/M^3)	Water (Kg/m^3)	RHA(Kg/m^3)	20mm Aggregate (Kg/m^3)	12.5 Mm Aggregate (Kg/m^3)	Fine Aggregate Kg/m^3		W/C
							Sand	M Sand	
1	0%-0%	304.5	197	53.7	452	552.5	768.4	0	0.55
2	15%-25%						576.2	192.0	
3	15%-50%						384.15	384.15	
4	15%-75%						192.0	576.2	
5	15%-100%						0	768.3	

Table 4: Mix Proportions

B. Casting of Cubes

Cubes with dimension 150 x 150 x 150 mm were used for compression strength, ultra-pulse velocity test, rebound hammer test. These moulds were casted conforming to relevant codes of Indian standards. The casting of specimen, moulds were cleaned and lubricated with oil and all the bolts are fastened tightly so that there is no leakage in the mould

C. Casting of Cylinders

Cylinders with the dimension of 10x20 mm are used for casting which is further used to test for durability tests. The specimens which are cured in water for 28days and tests to be conducted. These are casted to relevant data mentioned in Indian Standard Codes.

E. Water

The water percentage used in the concrete to include the properties of fresh and harden which includes compressive strength, workability, permeability, durability, drying shrinkage and potential for cracking. It reduces the amount of absorbent by the aggregates to the amount of the cementitious ratio, such that it is called as the water-cemtitious ratio (w/cm). As the water-cemtitious ratio amount is decreased it controls the hardened concrete by increasing the past density which further increase the durability and reduces the chemical attacks.

III. METHODOLOGY

In this experimental investigation by using IS 10262:2009 prepared five concrete mix designs normal strength concrete of 20MPA on bases of the physical properties of the materials. In this experimental investigation the five mixes of concrete is prepared by using the rice husk ash (RHA) replacing of cement with 15% for all the five mixes and the river sand is replaced by M-sand with different percentages of 25%,50%,75%and 100% for five mixes respectively.

A. Mix Design

The mix design is done by based on the IS 10262:2009 and the volume of the aggregate proportions is taken by trail mix depending on the ZoneI

D. Curing

After remoulding the specimen by loosening the screws of the moulds, the cubes allowed to dry for one day before placing them in the temperature controlled curing for period of 28 days.

E. Experimental Program

In this experimental work the tests may be conducted slump test, compressive strength test. ultra pulse velocity, Rebound Hammer tests for concrete is tests for the cubes sized 150 x 150 x 150 mm on 45 no of casted cubes for the period of 7, 14, 28 days and Acid Resistance, water absorption, sorptivity tests were conducted on the cylinders 100mm x 200 mm sized on 27 number of cylinders where casted and tested of the periods of 28, 56, 90 days.

F. Slump Test

The slump test is conducted on fresh concrete for determine workability of the concrete. The slum test is not suitable for the concrete very wet condition and also very dry condition. This test commonly conducted either laboratory or field for determining the workability of the concrete.

This test is conducted by using of the slump cone of a dimensions of the cone is bottom diameter of the cone is 20 cm, top diameter of the cone is 10 cm and the overall height of the cone is 30 cm.

This test is simple and easy for determination of the workability of the concrete when compare to the other tests such as compaction factor test and Vee- bee test.

In this experimental investigation by using the slump cone the concrete placed in the cone with three layers and each layer gives the blows 25 by tamping rod around the cross section of the concrete evenly and after the top layer completed finish the top surface with help of the trowel or tamping rod. Then the cone is removed the concrete is slowly down in vertical direction. Then the measure the slump by difference between the overall height of the cone and concrete is measured with help of measured scale in terms of mm it gives the slump of the concrete.

G. Compressive Strength

The compressive strength test is conducted for determining the compressive strength of a hardened concrete with a curing period of 3 days, 7 days, 14 days, 21 days and 28 days. The compressive strength is related to the characteristic properties of the concrete.

Normally, the determination of the compressive strength test is carried out on a specimen of cubes are used in our country. The size of the cube is 15 cm × 15 cm × 15 cm of on a volume of 3375 cm^3. In this test the nominal size of the aggregates does not exceed 20 mm.

In this experimental investigation the cubes are tested 7 days, 14 days and 28 days curing period of the average compressive strength. These tests of cubes are carried out by compressive testing machine of a compressive load of maximum 2000 KN. The cubes are placed on the compressive machine apply the load the breaking of the cube under a sustainable load is the ultimate load of the cube is noted. The Compressive strength is find out by following formula and units of compressive strength is N/mm^2

Compressive strength = P/A

In this experimental program tests are conducted for the casted cubes and cylinders. The compressive strength, ultra pulse velocity, Rebound Hammer tests for concrete is tests for the cubes sized 150 x 150 x 150 mm on 45 no of casted cubes for the period of 7, 14, 28 days and Acid Resistance, water absorption, sorptivity tests were conducted on the cylinders 100mm x 200mm sized on 27 number of cylinders where casted and tested of the periods of 28, 56, 90 Days.

H. Ultra-Pulse Velocity Test

This test is measured by the time taken to travel the waves from path to the other with the calculation of the speed. Mostly when to check the concrete was a good quality this method is adopted, it was used all over the world as it was the experimental investigation the ultrasonic pulse velocity machine is battery operated fully digital machine was used for testing the concrete cubes.

We can check the concrete quality when it has higher velocity in terms of the density, uniformity, homogeneity etc,.

The procedure is carried out by the two transducers off called transmitter and receiver which are connected to the sockets. To check whether the reading is in zero is by the reference bar. By the application of the grease to the transducer before placing them to the surfaces of the concrete cubes helps to the easily passage of the ultra pulse waves. Places the transducers on the surface and press it hard on it. note the readings until the transducers shouldn't move from the placed one. Pulse velocity is calculated by the path length divided with the time taken to travel for the wave propagation.

Pulse velocity = (Path length/Travel time)

I. Rebound Hammer Test

Schmidt's Rebound Hammer equipment consists of spring control hammer that slides on a plunger with the reader in the middle of the equipment. This is one of the alternative methods to know the strength of the concrete. Mainly this equipment used in the in-site on the columns and beams casted in the site. It was the easy to carry and to test the structures. When the plunger is forced against the surface of the concrete, the spring pushes opposite to the surface such that the mass of the rebounds from the plunger is noted. The hammer impact guides the scale to take the readings.

This test can be done in any direction with horizontally, vertically, upwards and downwards at any intermediate points and angles. With the calibration to the reading of hammer and the chart the strength is founded.

J. Water Absorption Test

Water absorption test was conducted on cylindrical specimens of size 200 mm x 100 mm after 28 days of curing as per ASTM C 642-97. Three test specimens were cast and tested for each age and each mix. After each curing period, these specimens were oven dried for 24 hours at the temperature of 110^0c and oven dry weight of specimens were measured (W1). After oven drying, these test specimens were immersed in water and measured the weight of the saturated surface dry specimens at an interval of 24 hours (W2). This procedure was repeated for not less than 48 hours until the two successive readings was same.

Water absorption (%) = [(W2 - W1) / W1] x 100

Where,

W1 = dry weight of specimen

W2 = weight of saturated surface dry specimen

K. Acid Resistance Test

The Acid Resistance Test was conducted on concrete cylinders size of 100mm x 200 mm. ASTM C 267 was used as the basic standard for this testing procedure. Three test specimens were cast and tested for each age and each mix. After each curing period, The test specimens were immersed in 4% sulfuric acid solution for 28 days. After 28 days, the cylinders were removed from the solution and their saturated dry weight was measured after smooth brushing by a nylon

brush. The weight of the specimens was compared with their initial values before testing.

Percentage of loss in Weight = [(W0 – W1) / W0] x 100

Where,

W0 = Weight before immersion (kg)

W1 = Weight after immersion (kg)

L. Sorptivity Test

This test is obtained not only for the strength but also to know the durability of the cylinder. Test is conducted for the cylinder of size 10 x 5 mm size of the cylinder cube which is taken from the middle part of the cylinder as it was well finished, compacted firmly and the materials where casted without any voids in. The cylinder specimens where taken with different proportion of the concrete cubes along with the difference in the curing period. The main material used in this test was Resign and Hardener which is used as the coating for the specimen.

Resign is played vital role in this test because this test mainly depends on the capillarity rise. Resign is used as the water repellent coater which is mixed with the hardener. When the structure is constructed under the water this is useful to withstand the structure.

Procedure is carried out with the resign paste coating and after the taken for 24 hours to dry the coat. It was secured with the plaster only to be attached to the concrete leaving the bottom surface of the specimen. Take out the pan and fill the water up to the 5mm of the bottom surface of the specimen to be touched. to the support the specimen is placed on the sticks which is helpful to be drained in the water more than 5mm.

Certain time intervals the results to be noted until they are of common values. To determine the sorptivity coefficient, the mass gain divided by the surface area with the density of water and to be added with the square root of time variable and the initial sorption in mm.

$$I=S.t^{0.5}$$

Where,

S= sorptivity in mm,

t=elapsed time in mint.

IV. RESULTS AND DISCUSSIONS

The results of the tests conducted on fresh concrete and hardened concrete. The tests conducted on fresh concrete are slump test and the tests conducted on hardened concrete are destructive test, such as compressive strength, Rebound hammer test, ultra-pulse velocity test. For cylinders acid resistance, water absorption, sorptivity were conducted.

The test results cover the strength properties of concrete using manufactured sand as replacement of fine aggregate (25%, 50%, 75%, 100%) in this concrete, cement was replaced with rice husk ash at 15%.

A. Slump Test

In this experimental investigation the slump test conducted for fresh concrete by using the slump cone for all the five concrete mixes. The Table 5 shows the respective values of the slump and the Figure: 4.1 is the curves shown of respective values of the slump with percentages of the M Sand 0%, 25%, 50%,75% and 100% for all the five mixes of the concrete.

S.No	RHA & M sand (%)	Slump (mm)
1	0-0	70
2	15-25	95
3	15-50	105
4	15-75	90
5	15-100	85

Table 5: Slump for Different Percentages of the M-Sand

B. Compression Test

In this experimental investigation the compressive strength test is conducted for hardened concrete on cubes o by using the compressive machine of 2000 KN. The cubes are prepared based on the mix design and the test is conducted under curing period of 7 days, 14 days and 28 days.

The Table 6 gives the 7 days, 14 days, and 28 days compressive strength with respective percentages 0%, 25%, 50%, 75% and 100%.

S. No	M20 Mix RHA &M-Sand (%)	7 Days Compressive Strength (N/mm^2)	14 Days Compressive Strength (N/mm^2)	28 Days Compressive Strength (N/mm^2)
1	0-0	14.5	22	26
2	15-25	17	24.2	28.5
3	15-50	21.5	26.7	32.4
4	15-75	19.7	24.4	27.8
5	15-100	20.2	23	26.5

Table 6: Compressive Strengths for Different Proportions

C. Ultrasonic Pulse Velocity Test

In this section includes Ultrasonic Pulse Velocity of both Conventional Concrete and RHA based Concrete mixes at different curing periods. The Table shows the ultrasonic pulse velocity values of CC and concrete with replacement of M-Sand and RHA.

S. NO	Mix Proportions (%)	7 Days Results		14 Days Results		28 Days Results	
		UPV (m/s)	Compressive Strength (N/mm^2)	UPV (m/s)	Compressive Strength (N/mm^2)	UPV (m/s)	Compressive Strength (N/mm^2)
1	0-0	3622	14.5	3916	22	4119	26
2	15-25	4111	17	4295	24.2	4442	28.5
3	15-50	3785	21.5	3852	26.7	4009	32.4
4	15-75	3622	19.7	3657	24.4	3952	27.8
5	15-100	3417	20.2	3578	23	3805	26.5

Table 7: Ultra Sonic Pulse Velocity Test Result

D. Rebound Hammer Test

In this section the Rebound Numbers of both Conventional concrete and RHA based concrete mixes were studied at different curing periods. Table shows the Rebound number

values of concrete made with partial replacement of Manufactured Sand and Rice Husk Ash.

S.No	M20 Mix (RHA-MSAND) (%)	Compressive Strength (N/mm^2)			Rebound Number		
		7 days	14 days	28 days	7 days	14 days	28 days
1	0-0	14.5	22	26	18.4	20.7	22.4
2	15-25	17	24.2	28.5	22.7	26.8	24.5
3	15-50	21.5	26.7	32.4	26.7	27.5	29.5
4	15-75	19.7	24.4	27.8	26.5	26	27.3
5	15-100	20.2	23	26.5	22.8	27	23.3

Table 8: Compression Strength from Rebound Number

E. Water Absorption Test

In this section water absorption of both Conventional Concrete and RHA based Concrete mixes were studied at different periods. Table shows the water absorption values of concrete made with partial replacement of Manufactured Sand and Rice Husk Ash.

S.NO.	Mix Proportions (%)	Percentage loss in water absorption (%)		
		24 Days Test Results	56 Days Test Results	90 Days Test Results
1	0-0	0.98	1.24	0.38
2	15-25	1.15	1.53	0.52
3	15-50	3.24	2.18	0.66
4	15-75	3.29	2.47	0.77
5	15-100	3.18	2.78	1.52

Table 9: Percentage Loss Water Absorption Test Results

F. Acid Resistance Test:

In this section Acid Resistance of both Conventional Concrete and RHA based Concrete mixes were studied at different curing periods. Table shows the acid resistance values of concrete made with partial replacement of M Sand and RHA.

S.NO	Mix proportions (%)	ACID RESISTANCE (%)		
		24 days test results	56 days test results	90 days test results
1	0-0	8.4	0.58	0.28
2	15-25	8.6	1.48	0.51
3	15-50	9.4	2.15	0.62
4	15-75	10.2	2.45	0.69
5	15-100	8..2	2.9	1.48

Table 10: Acid Resistance Test Results

G. Sorptivity:

Sorptivity test is conducted on the cylindrical specimen who is cut one third of its length. With the resin coating applied on to the cylinders to the capillary rise which is covered with the tape leaving the bottom surface. The following are the data for sorptivity test and graphical representation.

S.NO	RHA & M-Sand (%)	W_1 DRY WEIGHT (kg)	W_2 WET WEIGHT (kg)	TIME ($T^{0.5}$) (min)	SORPTIVITY VALUE IN 10^{-5} ($min/min^{0.5}$)
1	0-0	0.9	1.0	35	1.0
2	15-25	1.1	1.1	75	1.4
3	15-50	1.00	1.1	45	1.8
4	15-75	1.1	1.1	60	4.9
5	15-100	1.2	1.2	30	6.9

Table 11: Sorptivity Test Data

V. CONCLUSIONS

Based on the results of these experimental investigations, the following conclusions can be drawn:

1) Based on the test results if the fineness modulus of sand is increases strength is increased but certain limit the strength is decreased due to specific surface area of the fine aggregate.
2) Based on the tests results the maximum compressive strength of 32.4 N/mm2 for 15% of RHA and 50% of M sand with replacement of cement and sand respectively.
3) By Ultra pulse velocity, compression strength is maximum at the replacement of 15% rice husk ash and 25% manufactured sand.
4) Based on the rebound numbers in the rebound hammer test the compression strength is maximum in 15-50% of rise husk ash and manufactured sand.
5) Water absorption test conducted on the cylinders results the amount of percentage in water absorption is increased in 15-75% of RHA & M-Sand. It has lesser absorption in 25% of manufactured sand and 15% of rise husk ash.
6) Acid attacks on the cylinders were conducted and it results with lesser resistance in 75% of manufactured sand replacement and it has good resistance in 25% of manufactured sand.
7) Sorptivity is the test which results in capillarity and it has less capillary rise in 15-25% replacement.

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